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AGRICULTURAL MACHINERY ASSEMBLY AND LUBRICATION. AGRICULTURAL MACHINERY--SERVICE OCCUPATIONS, MODULE NUMBER 7.

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ONE OF A SERIES DESIGNED TO HELP TEACHERS PREPARE POSTSECONDARY STUDENTS FOR THE AGRICULTURAL MACHINERY SERVICE OCCUPATIONS AS PARTS MEN, MECHANICS, MECHANIC'S HELPERS, AND SERVICE SUPERVISORS, THIS GUIDE AIMS TO DEVELOP STUDENT UNDERSTANDING OF THE FUNCTIONS OF LUBRICANTS FOR AGRICULTURAL MACHINERY, SKILL IN THEIR SELECTION, AND UNDERSTANDING OF MACHINERY ASSEMBLY AND ADJUSTMENT. IT WAS DEVELOPED BY A NATIONAL TASK FORCE ON THE BASIS OF RESEARCH FROM STATE STUDIES. SUGGESTIONS FOR INTRODUCING THE MODULE ARE GIVEN. THE UNITS ARE ORGANIZED INTO SUGGESTED SUBJECT-MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, INSTRUCTIONAL MATERIALS, REFERENCES, AND OCCUPATIONAL EXPERIENCES. SUGGESTED TIME ALLOTMENT IS 9 HOURS OF CLASS INSTRUCTION, 129 HOURS OF LABORATORY EXPERIENCE, AND 60 HOURS OF OCCUPATIONAL EXPERIENCE. TEACHERS SHOULD HAVE EXPERIENCE IN AGRICULTURAL MACHINERY. STUDENTS SHOULD HAVE MECHANICAL APTITUDE AND AN OCCUPATIONAL GOAL IN AGRICULTURAL MACHINERY. THIS DOCUMENT IS ALSO AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 488 THROUGH VT 000 504) FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212, FOR $7.50 PER SET. (JM)

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AGRICULTURAL MACHINERY ASSEMBLY AND LUBRICATION

One of Sixteen Modules in the Course Preparing for Entry in

AGRICULTURAL MACHINERY - SERVICE OCCUPATIONS

Module No. 7

The Center for Research and Leadership Development

in Vocational and Technical Education

The Ohio State University
980 Kinnear Road
Columbus, Ohio, 43212

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M E M O R A N D U M

TO: The ERIC Clearinghouse on Vocational and Technical Education
The Ohio State University
980 Kinnear Road
Columbus, Ohio 43212

FROM: (Person) James W. Hensel (Agency) The Center for Vocational and Technical Education

(Address) 980 Kinnear Road, Columbus, Ohio 43212

DATE: August 4, 1967

RE: (Author, Title, Publisher, Date) Module No. 7, "Agricultural Machinery Assembly and Lubrication," The Center for Vocational and Technical Education, August, 1965.

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Provide information below which is not included in the publication. Mark N/A in each blank for which information is not available or not applicable. Mark P when information is included in the publication. See reverse side for further instructions.

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(3) Utilization of Material:
Appropriate School Setting Post high school
Type of Program General post high school class in agricultural machinery
Occupational Focus Agricultural machinery service occupations
Geographic Adaptability Nationwide
Uses of Material Instructor course planning
Users of Material Teachers

(4) Requirements for Using Material:
Teacher Competency Background in agricultural machinery
Student Selection Criteria Post high school, mechanical aptitude, high school background, goal in agricultural machinery service occupation.
Time Allotment Estimated time listed in module. (P)

Supplemental Media --
Necessary x
Desirable
(Check Which)

Describe Suggested references given in module. (P)

Source (agency)
(address)

AGRICULTURAL MACHINERY ASSEMBLY AND LUBRICATION

CONTENTS

	Page
Suggestions for Introducing the Module	1
Competencies to be Developed	
I. To understand the functions of lubricants for agricultural machinery and know how to select them properly	2
II. To (1) understand machinery assembly and adjustment and (2) develop the ability to assembly it	9
Suggestions for Evaluating Educatibnal Outcomes of the Module	11
Sources of Suggested References	11

AGRICULTURAL MACHINERY ASSEMBLY AND LUBRICATION

Major Teaching Objectives

To develop (1) an understanding of agricultural machinery assembly and lubrication procedures and (2) the ability to assemble and lubricate such machinery efficiently and correctly.

Suggested Time Allotments

At school		
Class instruction	9 hours	
Laboratory experience	129 hours	
Total at school		138 hours
Occupational experience		60 hours
Total for module		198 hours

Suggestions for Introducing the Module

Assembly of agricultural machinery has become a very important function of the service department in the agricultural machinery dealership. Machines are sent from the branch house or factory in as many small components as possible. This is done to cut down on freight costs as well as machinery damages while in transit to the agricultural machinery dealership. These components are stored in the dealership's warehouse until they are to be assembled and sold. The set-up man must be able to identify each machine part and understand its function in the machine's overall operation if he is to assemble the new machine properly. When the machine is assembled, he must be able to adjust and lubricate it properly to insure its proper operation under field conditions.

Following are some suggested techniques for creating interest when teaching the module.

1. Show the class a torn down tractor engine fouled by sludge and varnish build-up which may have been caused in part by improperly selected lubricants.

2. Bring to class several new machine parts. Have the class attempt to identify the machine using those parts and describe the function of each in the machine's operation.

3. Reverse the action of a manure spreader. Have students attempt to identify why the machine is running backwards. Emphasize how just a switch in the position of one part can affect the entire operation of a machine.

Competencies to be Developed

I. To understand the functions of lubricants for agricultural machinery and know how to select them properly

Teacher Preparation

Subject Matter Content

The factor that contributes most to the longevity of agricultural machinery is proper lubrication. It is important that agricultural machines be lubricated regularly and thoroughly. In order to lubricate agricultural machines properly, the person doing the lubrication must understand the reasons for using specific lubricants for different applications.

The primary reason for lubricating agricultural machines is to reduce the resistance (friction) between two moving parts which are in contact with each other.

Two types of friction develop in agricultural machinery, namely: (1) dry friction and (2) viscous friction.

The movement in different directions of two parts of a machine that are in contact with each other causes dry friction.

1. It is the purpose of the lubricant to separate these two parts with a thin coating or layer of oil or grease.

2. The oil or grease acts as a cushion between the two pieces of metal, reducing the amount of impact, friction, and wear.

Viscous friction refers to the friction that occurs between molecules of a lubricant.

1. Moving machine parts which float on a layer of oil or grease eliminate any part-to-part contact.

2. With proper lubrication, the energy required to operate the moving parts is greatly reduced.

3. The amount of molecular friction that develops depends upon the viscosity or grade of lubricant being used.

4. The lower the viscosity of the oil, the less the amount of friction which develops.

Lubricants used on agricultural machinery may be placed in three groups. They are:

1. Crankcase oil
2. Gear oil
3. Lubricating grease

Crankcase oil has five important functions to perform as a lubricant. They are:

1. To reduce friction and wear between surfaces
2. To remove heat caused by friction
3. To provide a seal against escaping gases
4. To keep the engine clean
5. To provide protection against rusting and attack by acids

Oils have been continuously improved to meet these demands. Most of this improvement has come about through the use of additives.

1. Oxidation and corrosion inhibitors have been added to oils to cut down on varnishes, sludges, and corrosive acids produced in the engine.
2. Detergent-dispersants have been added to give a cleaning action to oil.

When servicing a tractor for delivery to a farmer, the service man must decide what oils to use. He needs to know:

1. The oil grade or viscosity to use
2. The oil type to use (American Petroleum Institute--API service classification)

Viscosity is a term used to describe how fluid an oil is, or its resistance to flow. The heavier the grade of oil, the higher is its viscosity. Oils come in two viscosity grades.

1. Single-viscosity (SAE: 5W, 10W, 20, 20W, 30, 40, 50)
2. Multi-viscosity (SAE: 5W-20, 5W-40, 10W-30, 20W-40)

The use of the right oil is important in maintaining overall machinery efficiency.

1. If too light a grade of oil is used, it may be forced out from between the bearing surfaces allowing direct part-to-part contact, and therefore, causing very rapid wear.

2. When too heavy a grade of oil is used, the engine has to produce extra power needlessly in order to circulate the oil; if tight fitting bearings are present, they will be poorly lubricated.

Temperature greatly affects the ability of an oil to flow.

1. Oils without additives tend to thicken and increase in viscosity as the temperature decreases.

2. The same oil must be able to lubricate an engine at a starting temperature of $0^{\circ}F$ but still lubricate an engine with an internal temperature of $320^{\circ}F$.

3. The following table from an operator's manual illustrates proper selection of oil according to temperature ranges:

Air Temperature	Single Viscosity Grade	Multi-Viscosity Grade
Above $90^{\circ}F$	SAE 30	SAE 20W-40
$32^{\circ}F$ to $90^{\circ}F$	SAE 20W	SAE 10W-30
$-10^{\circ}F$ to $32^{\circ}F$	SAE 10W	SAE 10W-30
Below $-10^{\circ}F$	SAE 5W	SAE 5W-20

The use of a multi-viscosity grade of oil has the following advantages over the use of single-viscosity grades of oil.

1. Safer engine operation over a wider range of temperature conditions is maintained.

2. Easier engine starting in cold weather is possible.

3. There is less chance of burning or scoring main bearings and connecting rod bearings during those critical first few seconds of operation after starting.

4. Less oil consumption will occur.

5. One multi-grade oil may serve the needs of several engines requiring different single-grade oils.

In addition to selecting the proper oil viscosity, it is important that proper type of oil be used to fit the conditions under which the engine operates. The American Petroleum Institute (API) has developed a set of crankcase oil specifications for classifying gasoline and diesel motor oils. They are:

1. ML (motor light)
2. MM (motor moderate)
3. MS (motor severe)
4. DG (diesel general)
5. DM (diesel moderate)
6. DS (diesel severe)

The operator's manual recommends the type of oil service classification and grade to be used for different engine operating conditions. These should be carefully followed.

Gear oils are primarily used in the transmissions and rear-axle housings of agricultural machinery. In many respects they are similar to heavy crankcase oils, but their functions are somewhat different. They are given different viscosity-grade numbers (SAE: 80, 90, and 140) and different API classifications to prevent their being confused with crankcase oils.

As tractor horsepower has increased, gears have been improved to meet increased pressure and greater work loads. Gears have become smaller and tooth pressure has increased. In addition to the rolling action which occurs between gear teeth, gears go through a wiping action that tends to wipe away the oil layer separating the two gear surfaces. Additives have been added to gear oils to meet the more severe operating conditions now encountered and to cut down on the wear of gears caused by these increasingly severe operating conditions.

Temperature affects the viscosity of gear oils in the same manner that it affects crankcase oils. Therefore, it is necessary to consider viscosity grade and type classification when selecting gear oils.

1. Gear oil of proper viscosity has enough body to hold moving surfaces apart.
2. If gear oil is too heavy, engine power is wasted; the oil may channel and provide little or no lubrication thus making gears very hard to shift.

3. If the gear oil is too light, the oil film becomes so thin that high points on the sliding surfaces contact and wear rapidly.

Gear oils, like crankcase oils, contain certain kinds of additives depending upon their service classification. These additives include:

1. Anti-oxidants

2. Rust preventatives

3. Foam inhibitors

Lubricating grease is basically a lubricating oil with a soap-type thickening agent added to give it consistency. Different types of grease are used on agricultural machinery as determined by the operating requirements of a particular piece of equipment.

1. Lime soap is used in chassis grease; this results in a water-resistant grease that can be used anywhere where high operating temperatures are not present.

2. Soda soap is used to form a semi-smooth grease and is often referred to as wheel-bearing grease.

3. Lithium soap combines the water resistance and heat resistance of the other greases to provide a multi-purpose lubricant that is suitable for all-round use on farm machinery.

Suggested Teaching-Learning Activities

1. Obtain from a local service manager the shop records of the last month's repair jobs caused in part by faulty lubrication practices.

2. When introducing this competency, pass empty cans of different brands and API classifications around the class and raise the question, "Which oil would you use?"

3. Heat SAE 10 and SAE 40 viscosity grade oils to 100° and pour both down a smooth inclined plate to illustrate different flow characteristics. Repeat demonstration with both oils chilled by placing in ice water. Repeat with a multi-viscosity grade oil.

4. Demonstrate the viscosity of oils using the Saybolt viscometer for measuring motor oil viscosities. Cover half of a piece of window glass (single strength) with a SAE 50 oil film leaving the other half free of oil. Using a wooden mallet have a student tap the oil-free section a good tap making sure it breaks the first time. Have the student hit the oil covered section with the mallet at the same intensity. Emphasize that the oil acted as a cushioning agent, and as a result the glass didn't break. Show the class worn engine and agricultural machinery parts caused by varnishing, sludge, and corrosive acids.

5. On a glass plate, place a sample of a lime soap, soda soap, and lithium soap grease. Apply heat under each sample of grease noting the breakdown of the grease samples.

6. Drain the soil out of a tractor needing an oil change. Run the used oil through a filter to show the sludge deposited on the filter.

7. Have each student place a smear of unused and used oil and grease on microscope slides. Have them observe under the microscope the differences between the unused and used samples.

8. Show the class samples of the different types of oils and greases.

9. Have students develop a chart showing oil grade (viscosity) and oil type (API service classification) for different engines and working conditions.

10. Mix graphite, dirt, and then water into a clean quart of oil to emphasize what oil looks like when these foreign materials are added.

11. Have students inspect the surface of a piece of metal under a microscope noting the roughness of the surface. Emphasize the role of the lubricant in keeping the rough surfaces apart.

Suggested Instructional Materials and References

Instructional Materials

1. Samples of oil and grease of different types and grades

2. Saybolt viscometer

3. A 12" x 18" piece of single-strength glass and a wooden mallet

4. Worn engine and machine parts

5. A double strength piece of glass 12" x 12"

6. Grease samples of each soap type

7. A strainer and filter pad

8. Microscope slide plates and a microscope (might be borrowed from the biology teacher)

9. Charts on the characteristics of oils and lubricants

10. Operator's manuals for machinery used in the laboratory

11. Empty oil cans of different brands marked with the various API service classifications

12. A piece of metal

13. Materials for demonstrating impurities in oils

References

S*1. Engineering Bulletin Ft. 53, pages 59-74 and 79-82.

S 2. Gulf Farm Tractor Guide, pages 12-15.

S 3. Modern Farm Power, pages 143-151.

S 4. Tractor Fuels and Lubricants, pages 27-45.

*The symbol T (teacher) or S (student) denotes those references designed especially for the teacher or for the student.

Suggested Occupational Experience

Have students lubricate several new machines, using the operator's manual as the lubrication guide.

II. To (1) understand machinery assembly and adjustment and (2) develop the ability to assemble it

Teacher Preparation

Subject Matter Content

The operator's manual or assembly manual for each machine gives instructions for setting up and adjusting new agricultural machines. It provides the following information:

1. Proper operating instructions
2. Servicing requirements
3. Proper attachment, adjustment, and servicing of machine accessories
4. Machine assembly instructions
5. Machine specifications

It is important that the set-up man thoroughly understand the operation of the machine before he attempts to assemble and service it. The following procedure should be followed in setting up new agricultural machines.

1. Study carefully the operator's manual for the machine. Thoroughly understand its operation, adjustment, and servicing requirements.
2. Using the operator's manual as a guide, identify and collect the parts needed to assemble the machine.
3. Assemble the machine following the assembly instructions in the operator's manual.
4. Make all adjustments according to the specifications as listed in the operator's manual.
5. Properly lubricate the new machine.
6. Touch up any scuffs or chips in the paint caused in assembling it.

Suggested Teaching-Learning Activities

1. Have a local agricultural machinery dealer speak to the class on the importance of setting up machinery in his dealership. He should point out the correct procedures to use in assembling machinery.

2. Procedures outlined in the operator's or assembly manuals should be followed carefully in assemblying the machines listed below. Have students assemble, adjust, and service these agricultural machines in the order indicated.

   a. Spike-tooth harrow

   b. Spring tooth harrow

   c. Grain elevator

   d. Flare-type grain wagon and running gear

   e. Manure spreader

   f. Disk plow

   g. Moldboard plow

   h. Row-crop planter

   i. Grain drill

   j. Row-crop cultivator

   k. Baler

   l. Corn or cotton picker

   m. Combine

   n. Loader

Suggested Instructional Materials and References

Instructional Materials

New unassembled agricultural machines

References

S Operator's manuals or assembly manuals

Suggested Occupational Experience

Have students set up machinery at the local agricultural machinery dealership under the supervision of the service department set-up man.

Suggestions for Evaluating Educational Outcomes of the Module

The following may be considered in evaluating the educational outcome of this module.

1. Student interest in the materials included in this module
2. The ability of the student to set up, adjust, and service new machines
3. The ability of the student to use properly the operator's manual in setting up new machines
4. Employer's evaluations of the quality of work done by the students on the job

Sources of Suggested References

1. Henderson, G. E. and Turner, J Howard. Tractor Fuels and Lubricants, 1964. Southern Association of Agricultural Engineering and Vocational Agriculture, Barrow Hall, University of Georgia, Athens, Georgia. Price: $1.20.
2. Promersberger, W J. and Bishop, F. E. Modern Farm Power, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962.
3. Engineering Bulletin FT 53, Basic Principals, Operations, and Maintenance, American Oil Company, Room 147, Box 6110-A, Chicago 80, Illinois, 1962. Price: $1.00.
4. Gulf Farm Tractor Guide, No. SP10293, Gulf Oil Corporations, Gulf Building, Houston, Texas. No charge.
5. Operator's or assembly manuals from machinery manufacturers.

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IN VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY
980 KINNEAR ROAD
COLUMBUS, OHIO, 43212

INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name_____

2. Name of school_____State_____

3. Course outline used: _____Agriculture Supply--Sales and Service Occupations
_____Ornamental Horticulture--Service Occupations
_____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report_____

5. To what group (age and/or class description) was this material presented?____
_____

6. How many students:
a) Were enrolled in class (total) _____
b) Participated in studying this module _____
c) Participated in a related occupational work experience program while you taught this module _____

7. Actual time spent teaching module:

		Recommended time if you were to teach the module again:
_____hours	Classroom Instruction	_____hours
_____hours	Laboratory Experience	_____hours
_____hours	Occupational Experience (Average time for each student participating)	_____hours
_____hours	Total time	_____hours

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (✓) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

	VERY APPROPRIATE	NOT APPROPRIATE
8. The suggested time allotments given with this module were:		
9. The suggestions for introducing this module were:		
10. The suggested competencies to be developed were:		
11. For your particular class situation, the level of subject matter content was:		
12. The Suggested Teaching-Learning Activities were:		
13. The Suggested Instructional Materials and References were:		
14. The Suggested Occupational Experiences were:		

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes_____No_____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

_____ _____
(Date) (Instructor's Signature)

_____
(School Address)